Arch. Geflügelk. 2001, **65** (4), 178–181, ISSN 0003-9098. © Verlag Eugen Ulmer GmbH & Co., Stuttgart

Effect of feeding dried citrus pulp on quail laying performance and some egg quality characteristics

Einfluss der Fütterung von getrocknetem Zitrusfruchtbrei auf die Legeleistung von Wachteln und einiger Eiqualitätsmerkmale

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Manuskript eingegangen am 31. Mai 2000, angenommen am 3. Dezember 2000

Introduction

Citrus pulp is a by-product of citrus processing industry, usually consisting of the remainders of orange, lemon, grapefruit and mandarin fruit, after the juice has been extracted (EL BOUSHY and VAN DER POEL, 1994).

In some countries, such as U.S.A., Brasil, Japan, Spain, Italy, Greece etc., the production of oranges occupies an important position in food industry (HUTTON, 1987). For this reason considerable quantities of citrus wastes (especially dried citrus pulp and dried citrus sludge) could be converted into a useful feedstuff. EL MOGHAZY and EL BOUSHY (1982b) classified citrus residues as dried citrus pulp (DCP) and dried citrus sludge (DCS). The nutrient composition of DCP (SCOTT et al., 1982; AEC, 1987) indicates that it has a low content of crude protein (6.0–6.5 %), metabolizable energy (ME = 5.5 MJ/kg), crude fat (3.0–4.6 %), total phosphorus (0.12 %), and essential amino acids. However, it is rich in crude fibre (12.0–13.0 %), calcium (1.4–2.0 %), and limonin (0.01 %). The content of protein varies depending on season, on proportion of processed fruits, and on amount of seeds present (EL BOUSHY and VAN DER POEL, 1994). Since lime is usually added to bind pectin, the calcium level in DCP is high in relation to phosphorus. Due to this unbalance, care has to be taken during formulation of poultry diets in order to guarantee the right ratio of Ca : P (GOHL, 1975).

DCP is ordinarily regarded as an energy feed (CULISSON and LOWREY, 1987; HUTTON, 1987). Because of the low content of crude protein and the high content of crude fibre, it has been fed mainly to dairy cattle and beef cattle at levels not more than 20–25 % of the ration (SPAIS, 1997).

Several research workers have discussed the value of the citrus residues as a feedstuff for broilers and layers (ANGALET et al., 1976; ELDRED et al., 1976; COLEMAN and SHAW, 1977; KARUNAJEEWA, 1978; EL MOGHAZY and EL BOUSHY, 1982a; VELLOSO, 1985). They have noticed that the incorporation of DCP in layers' diet up to a level of 5 % had no adverse effect on their performance (KARUNAJEEWA, 1978; VELLOSO, 1985). Nevertheless, no information on the use of dietary DCP as a feedstuff for quail appears to be available in literature. The purpose of the present study was to examine the effect of DCP on the quail laying performance and some egg quality characteristics.

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Materials and methods

From a total of 135 forty-two day-old Japanese quail (*Coturnix coturnix japonica*) 54 hens were randomly allocated in three groups (C = control group; A = 3 % DCP group; B = 6 % DCP group), individually weighed and housed in three cages per group: C = 14 quails, A = 21 quails, B = 19 quails

During the following period of 14 weeks (laying period), the birds of the control group received a basal diet (Table 1) calculated to contain 181 g crude protein/kg, 31.3 g crude fat/kg, 40.7 g crude fibre/kg, 11 g lysine/kg, 7.5 g methionine-cystine/kg, 32 g calcium/kg, 7.7 g total phosphorus/kg, and 2,640 kcal ME/kg, plus the appropriate mixture of vitamins and trace minerals. Birds in groups A and B were given the same basal diet in which DCP (60 g crude protein/kg, 17 g crude fat/kg, 100 g crude fibre/kg, 6.2 g calcium/kg, 1 g total phosphorus/kg) was incorporated in the proportions of 3 % and 6 %, respectively. All diets were calculated on isonitrogenous and isocaloric basis. Throughout the entire experiment, water and feed were provided *ad libitum*, while ambient temperature was continuously controlled and light (natural and artificial) was given for 24 hours a day (LUCOTTE, 1974).

During the laying period egg production was recorded every week (for 14 weeks), while eggshell quality was evaluated by measuring egg weight (nearest 0.1 g) and egg specific gravity at the 4th, 9th, 11th and 12th week of this period. Egg's specific gravity was measured according to the principle of buoyancy (SHORMULLER, 1965) by employing a suitably adapted analytical balance. The eggs were stored for 3 days in a cool place (t = 13–14 °C) before measurement. Hatchability was also evaluated three times at the start, middle and the end of laying period. At the end of the experiment (138th day of age), hens were weighed individually.

Data were subjected to one-way analysis of variance using the completely randomized design. Homogeneity of variances were checked using the Levene's test. The significant differences among treatment means were tested using Duncan's multiple range test at the 5 % probability level (STEEL and TORRIE, 1980).

Results and discussion

The results for body weight (BW) and body weight gain (BWG) of female quails are presented in Table 2. These results suggest that the feeding of laying quail with DCP,

Table 1. Composition[1] of experimental diets (g/kg)
Zusammensetzung[1] der Versuchsfuttermischungen (g/kg)

Ingredients	Diets[2]			Analyses (calculated)	Diets[2]		
	C	A	B		C	A	B
Ground yellow corn	575.3	571.0	565.0	Crude protein	181.0	181.0	181.0
Soya bean meal	215.5	224.2	231.1	ME (kcal/kg)	2640	2640	2640
Herring meal	35.0	35.0	35.0	Crude fat	31.3	30.5	29.8
Wheat bran	80.1	45.9	17.7	Crude fibre	40.7	40.0	40.0
Dried citrus pulp	–	30.0	60.0	Lysine	11.0	11.0	11.0
Limestone	68.6	67.0	63.0	Methionine+cystine	7.5	7.5	7.5
Dicalcium phosphate	15.8	17.5	18.9	Calcium	32.0	32.0	31.0
Salt	3.3	3.3	3.3	Total phosphorous	7.7	7.7	7.7
Lysine	1.3	1.1	1.0	Salt	4.0	4.0	4.0
Methionine	1.1	1.0	1.0				
Choline chloride-50	0.8	0.8	0.8				
Avatec-150[3]	0.5	0.5	0.5				
Endox[4]	0.2	0.2	0.2				
Mixture of vitamins and trace minerals[5]	2.5	2.5	2.5				

[1] Dry matter content 86.2 %
[2] C = Control group, A = 3 % dried citrus pulp group, B = 6 % dried citrus pulp group
[3] Lasalocid 15 %
[4] Antioxidant (BHT and ethoxyquine 50 : 50)
[5] Mixture supplied per kg of diet: 15,000 I.U vitamin A (as retinol), 1 mg vitamin B_1, 5 mg vitamin B_2, 25 mg niacin, 11 mg pantothenic acid, 0.5 mg vitamin B_6, 0.05 mg biotin, 1 mg folic acid, 600 mg choline, 0.01 mg vitamin B_{12}, 10 mg vitamin C, 2,400 I.U. vitamin D_3, 15 mg vitamin E, 2 mg vitamin K, 0.25 mg cobalt, 7.5 mg copper, 1.5 mg iodine, 40 mg iron, 50 mg manganese, 0.15 mg selenium and 50 mg zinc

Table 2. Effect of dietary inclusion of dried citrus pulp on body weight[1] of female Japanese quail
Die Wirkung des Zusatzes von Zitrusfruchtbrei zum Futter auf das Körpergewicht[1] von Japanischen Legewachteln

Experimental groups[2]	Initial body weight (g at the 42nd day of age)	Final body weight (g at the 138th day of age)	Body weight gain (g)
C (n = 14)[3]	221.1 ± 21,8[a]	221.8 ± 24.9[a]	0.7 ± 3.6[a]
A (n = 21)	220.2 ± 20.0[a]	242.0 ± 13.7[b]	21.8 ± 7.1[a]
B (n = 19)	215.7 ± 23.3[a]	247.9 ± 17.2[b]	32.2 ± 27.0[a]

[1] Values represent means ± s.d.
[2] C = Control group, A = 3 % dried citrus pulp group, B = 6 % dried citrus pulp group
[3] n = number of quail per group
[a-b] Means within each column with different superscripts are significantly differents ($P \leq 0.05$)

at the level of 3 % (group A) and 6 % (group B) in the diet, had a favourable effect ($P \leq 0.05$) on BW compared with the controls at the end of the experiment (138th day of age). It should be noticed that there was no significant ($P > 0.05$) difference between the BW of quail of groups A and B. Moreover, BWG was not significantly ($P > 0.05$) affected by the type of diet. These results are in agreement with those published by YANG and CHOUNG (1985) for laying hens fed diets supplemented with dried citrus peels at levels of 50, 100 or 150 g/kg and with those reported by VELLOSO (1985) who included up to 10 % orange pulp in diets for laying pullets to replace maize.

Table 3. Effect of dietary dried citrus pulp on egg production[1] and hatchability[1] of Japanese quail
Die Wirkung des Zusatzes von Zitrusfruchtbrei zum Futter auf die Eiproduktion[1] und die Schlupffähigkeit[1] Japanischer Wachteln

Experimental groups[2]	Average[3] egg production (%)	Average[4] hatchability (%)
C (n = 14)[5]	78.73 ± 15.20[a]	47.44 ± 3.33[a]
A (n = 21)	67.19 ± 13.20[b]	53.11 ± 6.02[ab]
B (n = 19)	71.92 ± 13.17[ab]	62.87 ± 7.64[b]

[1] Values represent means ± s.d.
[2] C = Control group, A = 3% dried citrus pulp group, B = 6% dried citrus pulp group
[3] Average for 14 weeks
[4] Average for 3 hatchings
[5] n = number of female quail per group
[a-b] Means within each column with no common superscripts indicate significant difference ($P \leq 0.05$)

Egg production and hatchability are displayed in Table 3. Concerning average egg production, the inclusion of 3 % DCP in quail diets resulted in a significant ($P \leq 0.05$) decrease (67.19 %) compared with the controls (78.73 %). On the contrary, the inclusion of 6 % DCP in quail diets had no adverse effect on the average egg production (71.92 %) compared with the controls. Moreover, there was no significant ($P > 0.05$) difference in egg production between groups A and B. Nevertheless, the results are in contrast with those of KARUNAJEEWA (1978) who found that egg production was not affected by the inclusion of 5 % citrus pulp. The results concerning hatchability showed a significant ($P \leq 0.05$) increase (62.87 %) for quails receiving 6 % DCP in their diet compared with the controls (47.44 %), whereas no differences ($P > 0.05$) were observed between groups C and A as well as between groups A and B. The higher hatchability in the case of group C can not be explained under our experimental conditions. However, we consider that this finding should be further investigated.

Data for egg weight are presented in Table 4. The results showed no significant ($P > 0.05$) differences for the eggs produced during the 4th week of the laying period among the groups C, A and B, whereas significant ($P \leq 0.05$) differences were occasionally observed for eggs

Table 4. Effect of dietary dried citrus pulp on egg weight[1] (g) of Japanese quail
Die Wirkung des Zusatzes von Zitrusfruchtbrei zum Futter auf die Eigewichte[1] Japanischer Wachteln

Experimental groups[2]	Week of laying period				
	4th	9th	11th	12th	Average (n = 60)
C (n = 15)[3]	12.36 ± 0.86^a	12.17 ± 0.70^a	12.09 ± 0.84^a	12.24 ± 1.06^a	12.22 ± 0.86^a
A (n = 15)	11.91 ± 1.02^a	12.23 ± 0.65^a	13.31 ± 1.10^b	13.02 ± 0.96^b	12.62 ± 1.09^b
B (n = 15)	12.07 ± 0.68^a	12.75 ± 0.63^b	12.94 ± 0.53^b	12.42 ± 0.84^{ab}	12.55 ± 0.74^b

[1] Values represent means ± s.d.
[2] C = Control group, A = 3 % dried citrus pulp group, B = 6 % dried citrus pulp group
[3] n = number of eggs per group
$^{a-b}$ Means within each column with no common superscripts indicate significant difference ($P \leq 0.05$)

Table 5. Effect of dietary dried citrus pulp on specific gravity (g/cc) of eggs[1] of Japanese quail
Die Wirkung des Zusatzes von Zitrusfruchtbrei zum Futter auf das spezifische Gewicht (g/cc) der Eier von Japanischen Wachteln

Experimental Groups[2]	Week of laying period				
	4th	9th	11th	12th	Average (n=60)
C (n = 15)[3]	1.071 ± 0.013^a	1.062 ± 0.014^a	1.069 ± 0.011^a	1.062 ± 0.006^a	1.066 ± 0.012^a
A (n = 15)	1.063 ± 0.010^{ab}	1.062 ± 0.005^a	1.068 ± 0.007^a	1.062 ± 0.009^a	1.064 ± 0.008^a
B (n = 15)	1.059 ± 0.013^b	1.060 ± 0.006^a	1.060 ± 0.010^b	1.060 ± 0.007^a	1.060 ± 0.009^b

[1] Values represent means ± s.d.
[2] C = Control group, A = 3 % dried citrus pulp group, B = 6 % dried citrus pulp group
[3] n = number of eggs per group
$^{a-b}$ Means within each column with no common superscripts indicate significant difference ($P \leq 0.05$)

produced during the 9th, 11th and 12th week. Average egg weight was significantly ($P \leq 0.05$) affected by the dietary treatment. The average egg weight in groups A (12.62 g) and B (12.55 g) was significantly ($P \leq 0.05$) higher than that in group C (12.22 g). There was no significant ($P > 0.05$) difference in egg weight between groups A and B. These results do not agree with those of VELLOSO (1985) who concluded that egg weight was not affected by the inclusion of up to 10 % orange pulp in diets for laying pullets.

The results concerning egg specific gravity are presented in Table 5. Egg specific gravity did not differ significantly ($P > 0.05$) in the 9th and 12th week of the laying period among the groups C, A and B, whereas significant ($P \leq 0.05$) differences were observed in the 4th and 11th week. Average egg specific gravity in group B (1.060 g/cc) was significantly ($P \leq 0.05$) lower than that in group C (1.066 g/cc) and A (1.064 g/cc). Moreover, there was no significant ($P > 0.05$) difference in egg specific gravity between groups C and A. ELDRED et al., (1976) found no significant differences in the specific gravity of the eggs when citrus sludge (citrus waste) was included up to 7.5 % in the diet of laying hens.

Mortality was not affected significantly ($P > 0.05$) throughout the laying period in all groups.

It is concluded that DCP could be used in diets for laying quails with no serious adverse effects on their performance.

Summary

In the present experiment the effects of supplementing quail's (*Coturnix coturnix japonica*) diet with dried citrus pulp (DCP) on laying performance and some egg quality characteristics were studied during a 14 weeks laying period. A total of 54 birds were allotted to 3 groups (control group, 3 % dried citrus pulp group, 6 % dried citrus pulp group). The birds of the control group received a basal diet, while those of the other 2 groups were given the basal diet with incorporation of DCP at the levels of 3 % and 6 %. DCP exhibited a favourable effect ($P \leq 0.05$) on quail's final body weight and egg weight. The hatchability and the egg specific gravity were influenced ($P \leq 0.05$) for inclusion level of 6 %, while egg production was influenced ($P \leq 0.05$) for inclusion level of 3 %. The results indicate that dried citrus pulp can be used at levels up to 6 % in laying quails' diets with no significant adverse effects on their performance.

Keywords

Quail, nutrition, dried citrus pulp, laying performance, egg quality

Zusammenfassung

Einfluss der Fütterung von getrocknetem Zitrusfruchtbrei auf die Legeleistung von Wachteln und einiger Eiqualitätsmerkmale

In der vorliegenden Untersuchung wurden bei der Japanischen Wachtel (Coturnix coturnix japonica) die Auswirkungen des Einsatzes von getrocknetem Zitrusfruchtbrei (DCP) im Futter auf die Legetätigkeit und einige Merkmale der Eiqualität über eine Legeperiode von 14 Wochen überprüft. Insgesamt wurden 54 Wachteln verwendet und in 3 Gruppen (Kontrollgruppe, 3 % DCP-Gruppe, 6 % DCP-Gruppe) eingeteilt. Die Wachteln der Kontrollgruppe erhielten ein konventionelles Futter, während dem Futter der beiden anderen Gruppen 3 % bzw. 6 % DCP zugesetzt wurde. Der Zusatz von DCP wirkte sich günstig ($P \leq 0,05$) auf das Körpergewicht der Wachteln und das Eigewicht aus. Die Schlupffähigkeit und das spezifische Gewicht der Eier wurde bei einem Gehalt von 6 % DCP beeinflusst ($P \leq 0,05$), während die Eiproduktion bei einem Gehalt von 3 % DCP beeinflusst wurde ($P \leq 0,05$). Diese Ergebnisse lassen den Schluss zu, dass getrockneter Zitrusfruchtbrei dem Futter von legenden Wachtelhennen ohne ernsthafte Nebenwirkungen auf deren Legetätigkeit bis zu einem Gehalt von 6 % zugesetzt werden kann.

Stichworte

Wachtel, Fütterung, getrockneter Zitrusfruchtbrei, Legentätigkeit, Eiqualität

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